Accelerated Insertion of Materials – Industrial Perspectives on Polymer Matrix Composites

by Gail L. Hahn
The Boeing Company
Mailcode S245-1018
8900 Frost Avenue
Berkeley, MO 63134-1004
gail.l.hahn@boeing.com
Phone: 314-233-1848
Fax: 314-777-6595

Session: Structural Composites, Keynote Address

Text: In June 2001, a group of eight people from various functions involved with the insertion of polymer matrix composite materials in airframe structures via qualification of materials and certification of structure met to capture "What are the problems or issues that arise when inserting a new composite material into new design or an existing product?" This was one of several such groups that later included certification customer groups as well. The results of these groups, which included disconnect between materials development and the intended use to the material (Figure 1) and the high cost of rework (Figure 2), were used to focus the developments of Accelerated Insertion of Materials – Composites (AIM-C) that has the objective to demonstrate concepts, approach, and tools that can accelerate the insertion of new materials into Department of Defense products. The AIM-C concept (Figure 3) is to utilize knowledge (heuristics, lessons learned, existing data), analysis techniques, and experimentation to develop a designer knowledge base (technical and production readiness information) from the outset, rather than the more traditional approach of sequential, unlinked research and development, sometimes locally optimized without a production readiness transition path.   The composite materials program is using carbon fiber/epoxy based resins for demonstration and validation at this time.

Mathematical techniques including design of traditional and computational experiments and propagation of error methodologies are employed to focus efforts and to provide confidence to material implementers via the necessary technical, cost, and schedule data for transition with associated risk and payoff. The AIM-C System is based on methodology developed in coordination with certifying personnel representing Department of Defense and commercial agencies. Databases, heuristic models based on lessons learned, and science based analysis models are flexibly connected in the framework of the Robust Design Computational System (RDCS).

Assessments indicate that the AIM-C methodology should accelerate insertion by 35-40% and result in a 4-fold reduction in rework costs. An integrated product team that used the methodology for the design of a hat stiffened panel estimates a cost avoidance in redesign of 15% in the product definition time frame even with a very early prototype of the AIM-C system used. Figure 4 schematically depicts the accelerated risk reduction

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2003	**N/A**	**-**

4. TITLE AND SUBTITLE
Accelerated Insertion of Materials Industrial Perspectives on Polymer Matrix Composites

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The Boeing Company Mailcode S245-1018 8900 Frost Avenue Berkeley, MO 63134-1004

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**4**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

attributed to early understanding of insertion requirements and addressing weaknesses and unknowns through early, focused investigation.

Acknowledgements: The effort discussed is a result of Technology Investment Agreement, N00421-01-3-0098, entitled "Accelerated Insertion of Materials – Composites" (AIM-C) that is being jointly accomplished by Boeing and the U.S. Government under the guidance of NAST as part of the Defense Advanced Research Projects Agency (DARPA) sponsored Accelerated Insertion of Materials (AIM) initiative. Dr. Leo Christodoulou of the Defense Sciences Office leads the initiative that is managed by Dr. Ray Meilunas of the Naval Air Systems Command. Charles R. Saff and Dr. Karl M. Nelson of Boeing are Deputy Program Managers, working closely with Gail L. Hahn, the Program Manager, who is also with Boeing.

Figures/Tables:

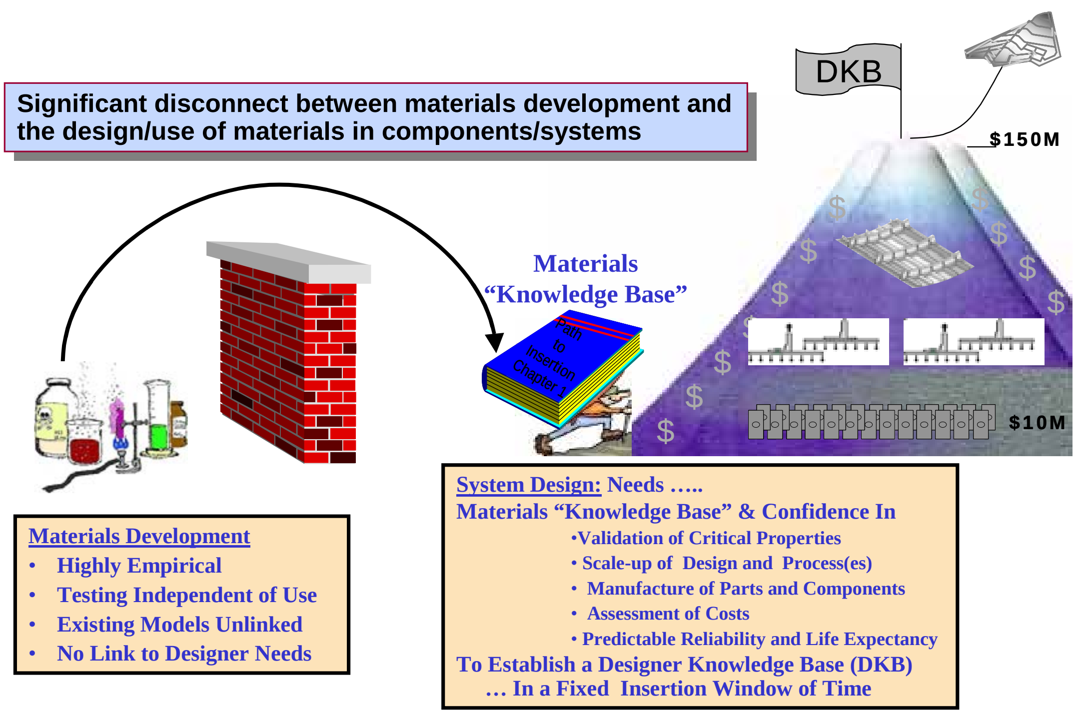
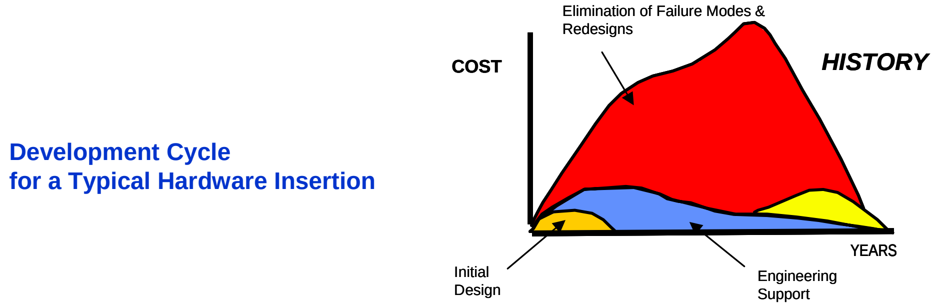


Figure 1. Industrial Perspectives on Polymer Matrix Composites are the Technical Motivation for the AIM-C Methodology



Implications of the current scenario:

- Risk Adversity – Stay with known materials and concepts

Figure 2. The Issue: Often, a majority of the time and money spent in the insertion process is for fixing problems because of poor material or process characterization and selection or poor design.

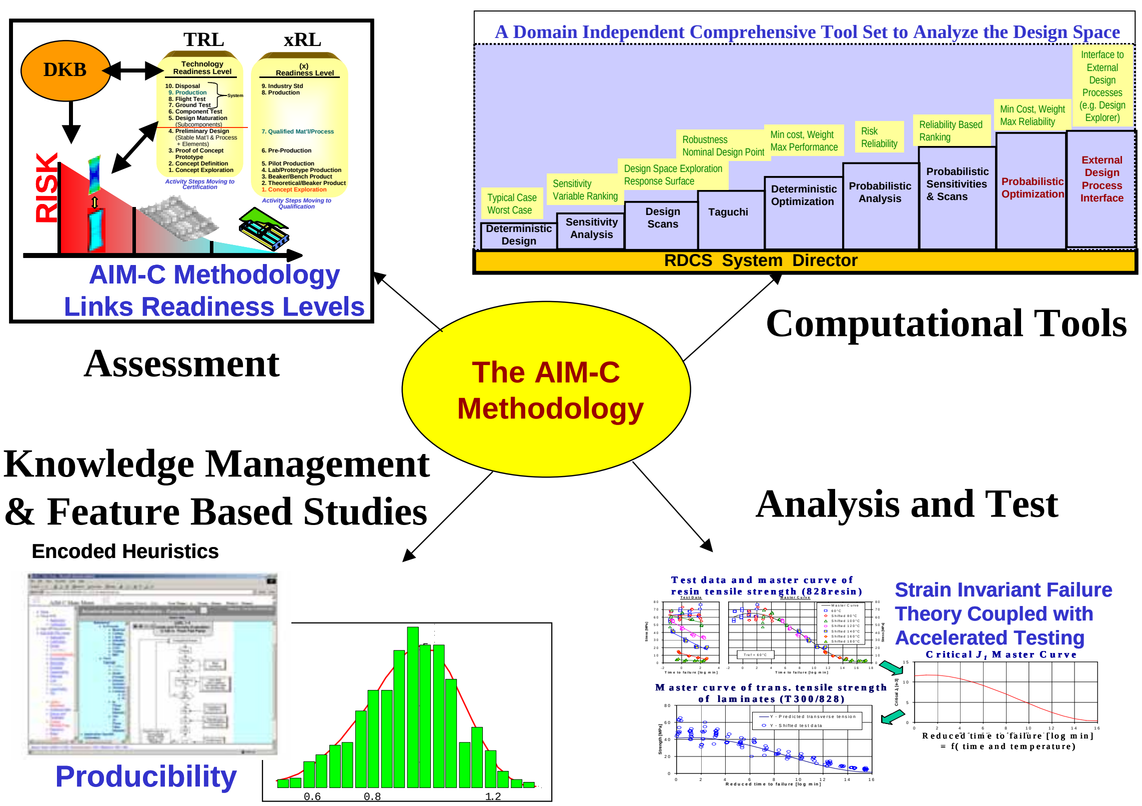


Figure 3. The AIM-C Methodology utilizes assessment, computational tools, knowledge management, feature based studies, analyses, and test to overcome obstacles to the accelerated insertion of materials.

Approved for Public Release, Distribution Unlimited

Figure 4. The AIM focus on designer knowledge base needs accelerates insertion risk reduction and the insertion itself.

Novel and Original Contributions of this Paper (Point-form Please):

- **Focused development and characterization on design knowledge base.**
- **Coordinated use of existing knowledge, analysis, and focused testing**
- **Applied physics based material and structural analysis methods**
- **Used integrated engineering processes and simulations**
- **Analyzed and managed uncertainty**
  - **Early feature based demonstration**
  - **Tracked variability and error propagation across scales**
- **Avoided rework**
- **Provided disciplined approach for pedigree management**
- **Orchestrated knowledge management to efficiently tie together the above elements to a design knowledge base for qualification and certification**